Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/GB05/002999

International filing date: 29 July 2005 (29.07.2005)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0417961.0
Filing date: 12 August 2004 (12.08.2004)

Date of receipt at the International Bureau: 26 September 2005 (26.09.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
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1. Your reference

   Shockwave 2

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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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   Patents ADP number *(if you know it)*

   08333072002

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4. Title of the invention

   Improvements to Fluid Mover

5. Name of your agent *(if you have one)*

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Signature(s) Date 11/08/04

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

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IMPROVEMENTS TO FLUID MOVER

[0001] This invention relates to improvements in fluid energy transfer mechanisms of fluid movers, with particular but not exclusive reference to the Fluid Mover described in our International Patent Application No PCT/GB2003/004400.

[0002] The present invention has reference to improvements to a fluid mover having a number of practical applications of diverse nature ranging from marine propulsion systems to pumping applications for moving and/or mixing fluids and/or solids of the same or different characteristics. The present invention also has relevance in the fields inter alia of heating, cooking, cleaning, aeration, gas fluidisation, and agitation of fluids and fluids/solids mixtures, particle separation, classification, disintegration, mixing, emulsification, homogenisation, dispersion, maceration, hydration, atomisation, droplet production, viscosity reduction, density reduction, and pasteurisation.

[0003] More particularly the invention is concerned with the provision of an improved fluid mover having essentially no moving parts.

[0004] Ejectors are well known in the art for moving working or process fluids by the use of a either a central or an annular jet which emits steam into a duct in order to move the fluids through or out of appropriate ducting or into or through another body of fluid. The ejector principally operates on the basis of inducing flow by creating negative pressure, generally by the use of the venturi principle. The majority of these systems utilise a central steam nozzle where the

induced fluid generally enters the duct orthogonally to the axis of the jet, although there are exceptions where the reverse arrangement is provided. The steam jet is accelerated through an expansion nozzle into a mixing chamber where it impinges on and is mixed with working fluid. The mixture of working fluid and steam is accelerated to higher velocities within a downstream convergent section prior to a divergent section, e.g. a venturi. The pressure gradient generated in the venturi induces new working fluid to enter the mixing chamber. The energy transfer mechanism in most steam ejector systems is a combination of momentum, heat and mass transfer but by varying proportions. Many of these systems employ the momentum transfer associated with a converging flow, while others involve the generation of a shock wave in the divergent section. One of the major limitations of the conventional convergent/divergent systems is that their performance is very sensitive to the position of the shock wave which tends to be unstable, easily moving away from its optimum position. It is known that if the shock wave develops in the wrong place within the convergent/divergent sections, the relevant unit may well stall. Such systems can also only achieve a shock wave across a restricted section.

[0005] Furthermore, for systems which employ a central steam nozzle, the throat dimension restriction and the sharp change of direction affecting the working fluid presents a serious limitation on the size of any particulate throughput and certainly any rogue material that might enter the system could cause blockage.

[0006] An improved Fluid Mover is described in our International Patent Application No PCT/GB2003/004400 in which the

interaction of a working fluid or fluids and a transport fluid projected from a nozzle arrangement provides pumping, entrainment, mixing, heating, emulsification, and homogenization etc. of the working fluid or fluids. The fluid mover introduces an annular supersonic jet of-transport fluid, typically steam, into a relatively large diameter straight through hollow passage. Through a combination of momentum transfer, high shear, and the generation of a supersonic shockwave, the high velocity steam induces and acts upon the working fluid passing through the centre of the hollow body.

[0007] The specification discloses the transport fluid is preferably a condensable fluid and may be a gas or vapour, for example steam, which may be introduced in either a continuous or discontinuous manner. At or near the point of introduction of the transport fluid, for example immediately downstream thereof, a pseudo-vena contracta or pseudo convergent/divergent section is generated, akin to the convergent/divergent section of conventional steam ejectors but without the physical constraints associated therewith since the relevant section is formed by the effect of the steam impacting upon the working or process fluid. Accordingly the fluid mover is more versatile than conventional ejectors by virtue of a flexible internal boundary. The flexible boundary lies between the working fluid at the centre and the solid wall of the unit, and allows disturbances or pressure fluctuations in the multi phase flow to be accommodated better than for a solid wall. This advantageously reduces the sonic velocity within the multi phase flow, resulting in better droplet dispersion, increasing the momentum transfer zone length, thus producing a more intense shockwave.

[0008] The specification further discloses that the positioning and intensity of the shock wave is variable depending upon the specific requirements of the system in which the fluid mover is disposed. The mechanism relies on a combination of effects in order to achieve its high versatility and performance, notably heat, momentum and mass transfer which gives rise to the generation of the shock wave and also provides for shearing of the working fluid flow on a continuous basis by shear dispersion and/or disassociation. Preferably the nozzle is located as close as possible to the projected surface of the working fluid in practice and in this respect a knife edge separation between the transport fluid or steam and the working fluid stream is of advantage in order to achieve the requisite degree of interaction. The angular orientation of the nozzle with respect to the working fluid stream is of importance and may be shallow.

[0009] Further, the specification discloses that the or each transport fluid nozzle may be of a convergent-divergent geometry internally thereof, and in practice the nozzle is configured to give the supersonic flow of transport fluid within the passage. For a given steam condition, i.e. dryness, pressure and temperature, the nozzle is preferably configured to provide the highest velocity steam jet, the lowest pressure drop and the highest enthalpy. For example only, and not by way of limitation, an optimum area ratio for the nozzle, namely exit area: throat area, lies in the range 1.75 and 7.5, with an included angle of less than 9°.

[0010] The or each nozzle is conveniently angled towards the flow since this occasions penetration of the working fluid and

advantageously may prevent both kinetic energy dissipation on the wall of the passage and premature condensation of the steam at the wall of the passage, where an adverse temperature differential prevails. The angular orientation of the nozzles is selected for optimum performance which is dependent inter alia on the nozzle orientation and the internal geometry of the mixing chamber. Further the angular orientation of the or each nozzle is selected to control the pseudo-convergent/divergent profile and the condensation shock wave position in accordance with the pressure and flow rates required from the fluid mover. Moreover, the creation of turbulence, governed inter alia by the angular orientation of the nozzle, is important to achieve optimum performance by dispersal of the working fluid in order to increase acceleration by momentum transfer. This aspect is of particular import when the fluid mover is employed as a pump. For example, and not by way of limitation, in the present invention it has been found that an angular orientation for the or each nozzle may lie in the range 0 to 30°.

[0011] A series of nozzles with respective mixing chamber sections associated therewith may be provided longitudinally of the passage and in this instance the nozzles may have different angular orientations, for example decreasing from the first nozzle in a downstream direction. Each nozzle may have a different function from the other or others, for example pumping, mixing, disintegrating, and may be selectively brought into operation in practice. Each nozzle may be configured to give the desired effects upon the working fluid. Further, in a multi-nozzle system by the introduction of the transport fluid, for example steam, phased heating may be

achieved. This approach may be desirable to provide a gradual heating of the working fluid.

[0012] An object of the present invention is to improve the performance of the fluid mover by enhancing the energy transfer mechanism between the high velocity transport fluid and the working fluid. This improves the performance of the fluid mover having essentially no moving parts having an improved performance than fluid movers currently available in the absence of any constriction such as is exemplified in the prior art recited in the aforementioned patent.

[0013] According to a first aspect of the present invention a fluid mover of the kind described in our aforementioned patent application , includes a hollow body provided with a straight-through passage of substantially constant cross section with an inlet at one end of the passage and an outlet at the other end of the passage for the entry and discharge respectively of a working fluid, a nozzle substantially circumscribing and opening into said passage intermediate the inlet and outlet ends thereof, an inlet communicating with the nozzle for the introduction of a transport fluid, a mixing chamber being formed within the passage downstream of the nozzle, the nozzle internal geometry and the bore profile immediately upstream of the nozzle exit being so disposed and configured to optimise the energy transfer between the transport fluid and working fluid that in use through the introduction of transport fluid the working fluid or fluids are atomised to form a dispersed vapour/droplet flow regime with locally sonic flow conditions within a pseudo-vena contracta, resulting in the creation of a supersonic shock wave within the downstream mixing chamber by the condensation of the transport fluid.

[0014] The transport fluid is preferably a condensable fluid and may be a gas or vapour, for example steam, which may be introduced in either a continuous or discontinuous manner.

[0015] According to a second aspect of the present invention a fluid mover of the kind described in our aforementioned patent application, includes a hollow body provided with a straight-through passage of substantially constant cross section with an inlet at one end of the passage and an outlet at the other end of the passage for the entry and discharge respectively of a working fluid, a nozzle substantially circumscribing and opening into said passage intermediate the inlet and outlet ends thereof, an inlet communicating with the nozzle for the introduction of steam, a mixing chamber being formed within the passage downstream of the nozzle, the nozzle internal geometry and the bore profile immediately upstream of the nozzle exit being so disposed and configured to optimise the energy transfer between the steam and working fluid that in use through the introduction of steam the working fluid or fluids are atomised to form a dispersed vapour/droplet flow regime with locally sonic flow conditions within a pseudo-vena contracta, resulting in the creation of a supersonic shock wave within the downstream mixing chamber by the condensation of the steam.

[0016] The nozzle may be of a form to correspond with the shape of the passage and thus for example a circular passage would advantageously be provided with an annular nozzle circumscribing it. The term 'annular' as used herein is deemed to embrace any configuration of nozzle or nozzles that circumscribes the passage of the fluid mover.

[0017] The or each nozzle may be of a convergent-divergent geometry internally thereof, and in practice the nozzle is configured to give the supersonic flow of transport fluid within the passage. For a given steam condition, i.e. dryness, pressure and temperature, the nozzle is preferably configured to provide the highest velocity steam jet, the lowest pressure drop and the highest enthalpy.

[0018] The or each nozzle is preferably optimally configured to operate with a particular working fluid, upstream wall contour profile and mixing chamber geometry. The nozzles, upstream wall contour profile and mixing chamber combination are configured to encourage working fluid atomisation creating a vapour/droplet mixed flow with local sonic flow conditions. This encourages the formation of the downstream condensation shockwave, by enhancing the heat transfer rate between the transport and working fluids by maximising surface contact between the fluids.

[0019] The or each nozzle is preferably configured to operate with a particular working fluid, upstream wall contour profile and mixing chamber to provide an optimum nozzle exit pressure. Initial pressure recovery due to transport fluid deceleration coupled with the pressure drop due to condensation are used to ensure the nozzle expansion ratio is adjusted to enhance atomisation of the working fluid and momentum transfer.

[0020] The exit velocity from the or each nozzle may be controlled by varying the steam supply pressure, the expansion ratio of the nozzle and the condensation profile in

the immediate region of the mixing chamber. The nozzle exit velocities may be controlled to enhance Momentum Flux Ratios $\dot{M}$ in the immediate region of the mixing chamber. Where $\dot{M}$ is defined by the equation

$$\dot{M} \equiv \frac{\left(\rho_s \times U_s^{\,2}\right)}{\left(\rho_f \times U_f^{\,2}\right)}$$

Where ρ = Fluid density

U = Fluid velocity

Subscript s represents steam

Subscript f represents working fluid

[0021] In the present invention it has been found that an optimum Momentum Flux Ratio $\dot{M}$ for the or each nozzle lies in the range $2 \leq \dot{M} \leq 70$. For example, when using steam as the transport fluid, with a working fluid with a high water content, $\dot{M}$ for the or each nozzle lies in the range $5 \leq \dot{M} \leq 40$

[0022] The or each nozzle is configured to provide the desired combination of axial, radial and tangential velocity components. It is a combination of axial, radial and tangential components which influence the primary turbulent break-up (atomisation) of the working fluid flow.

[0023] The interaction between the transport fluid and the working fluid, leading to the atomisation of the working fluid, is enhanced by instability. Instability enhances the droplet stripping from the contact surface of the core flow of the working fluid. A turbulent dissipation layer between the

transport and working fluids is both fluidically and mechanically (geometry) encouraged ensuring rapid fluid core dissipation. The pseudo-vena contracta is a resultant aspect of this droplet atomisation region.

[0024] The internal walls of the flow passage upstream of the or each nozzle may be contoured to provide a combination of axial, radial and tangential velocity components of the outer surface of the working fluid core when it comes into contact with the transport fluid. It is a combination of these velocity components which inter alia influence the primary turbulent break-up (atomisation) of the working fluid when it comes into contact with the transport fluid.

[0025] Under optimum operating conditions the disintegration or atomisation of the working fluid core is extremely rapid. The disintegration across the whole bore will typically take place in the mixing chamber within, but not limited to, a distance approximately equivalent to 0.66D downstream of the nozzle exit. Under different non-optimised operating conditions disintegration across the whole bore of the mixing chamber, may still occur within, but not limited to, a distance equivalent to 1.5D downstream of the nozzle exit. Where D is the nominal diameter of the bore through the centre of the fluid mover.

[0026] A series of nozzles with respective mixing chamber sections associated therewith may be provided longitudinally of the passage and in this instance the nozzles may have different angular orientations, for example decreasing from the first nozzle in a downstream direction. Each nozzle may have a different function from the other or others, for example

pumping, mixing, disintegrating, and may be selectively brought into operation in practice. Each nozzle may be configured to give the desired effects upon the working fluid. Further, in a multi-nozzle system by the introduction of the transport fluid, for example steam, phased heating may be achieved. This approach may be desirable to provide a gradual heating of the working fluid.

[0027] In addition the internal walls of the flow passage immediately upstream of the or each nozzle exit may be contoured to provide different degrees of turbulence to the working fluid prior to its interaction with the transport fluid issuing from the or each nozzle.

[0028] The mixing chamber geometry is determined by the desired and projected output performance and to match the designed steam conditions and nozzle geometry. In this respect it will be appreciated that there is a combinatory effect as between the various geometric features and their effect on performance, namely there is interaction between the various design and performance parameters having due regard to the defined function of the fluid mover.

[0029] The improvements of the present invention may be employed to the fluid mover of the aforementioned patent, and enhance its use in a variety of applications as disclosed in the aforementioned patent. These applications range from use as a fluid processor, including pumping, mixing, heating, homogenising etc, to marine propulsion, where the mover is submersed within a body of fluid, namely the sea or lake or other body of water. In its application to fluid processing a variety of working fluids may be processed and may include

liquids, liquids with solids in suspension, slurries, sludges and the like. It is an advantage of the straight-through passage of the mover that it can accommodate material that might find its way into the passage

[0030] The fluid mover of the present invention may also be used for enhanced mixing, dispersion or hydration and again the combination of the shearing mechanism, droplet formation and presence of the shock wave provides the mechanism for achieving the desired result. In this connection the fluid mover may be used for mixing one or more fluids, one or more fluids and solids in particulate form, for example powders. The fluids may be in liquid or gaseous form. It has been found that the use of the present invention when mixing liquid with a powder of particulate form a homogeneous mixture results, even when the powder is of difficult to wet material, for example Gum Tragacanth which is a thickening agent.

[0031] The treatment of the working fluid, for example heating, dosing, mixing, dispersing, emulsifying etc may occur in batch mode using at least one fluid mover or by way in an in-line or continuous configuration using one or more fluid movers as required.

[0032] A further use to which the present invention may be put is that of emulsification which is the formation of a suspension by mixing two or more liquids which are not soluble in each other, namely small droplets of one liquid (inner phase) are suspended in the other liquid(s) (outer phase). Emulsification may be achieved in the absence of surfactant blends, although they may be used if so desired. In addition, due to the

straight through nature of the invention, there is no limitation on the particle size that can be handled, allowing particle sizes up to the bore size of the unit to pass through whilst emulsification is taking place.

[0033] The fluid mover may also be employed in the paper industry for disintegration of paper pulp. A typical example would be in paper recycling, where waste paper or broke pieces are mixed with water and passed through the fluid mover. A combination of the heat addition, the high intensity shearing mechanism and the shockwave both rapidly hydrates the paper, and macerates and disintegrates the paper pieces into smaller sizes. Disintegration down to individual fibres has been achieved in tests.

[0034] The straight through aspect of the invention has the additional benefit of offering very little flow restriction and therefore a negligible pressure drop, when a fluid is moved through it. This is of particular importance in applications where the fluid mover is located in a process pipe work and fluid is pumped through it when the fluid mover of the present invention is turned off. In addition, the clear bore offers no impedance to cleaning 'pigs' or other similar devices which may be employed to clean the pipe work.

[0035] A detailed description of the energy transfer mechanism, focussing on the momentum transfer between the transport fluid and working fluid by an enhanced shearing mechanism is best described with reference to the accompanying drawings. By way of example, six embodiments of geometrical features that may be employed to enhance this energy transfer mechanism in accordance with the present

invention are described below with reference to the accompanying drawings in which:

[0036] Figure 1 is a cross sectional elevation of a fluid mover;

[0037] Figure 2 is a magnified view of the shearing mechanism shown in Figure 1;

[0038] Figure 3 is a cross sectional elevation of a first embodiment.

[0039] Figure 4 is a cross sectional elevation of a second embodiment.

[0040] Figure 5 is a cross sectional elevation of a third embodiment.

[0041] Figure 6 is a cross sectional elevation of a fourth embodiment.

[0042] Figure 7 is a cross sectional elevation of a fifth embodiment.

[0043] Figure 8 is a cross sectional elevation of a sixth embodiment.

[0044] Like numerals of reference have been used for like parts throughout the specification.

[0045] Referring to Figure 1 there is shown a fluid mover 1 as described in the aforementioned Patent, comprising a housing 2 defining a passage 3 providing an inlet 4 and an outlet 5, the passage 3 being of substantially constant circular cross section.

[0046] The housing 2 contains a plenum 8 for the introduction of a transport fluid, the plenum 8 being provided with an inlet 10. The distal end of the plenum is tapered on and defines an annular nozzle 16. The nozzle 16 being in flow

communication with the plenum 8. The nozzle 16 is so shaped as in use to give supersonic flow.

[0047] In operation the inlet 4 being connected to a source of a working or working fluid. Introduction of the steam into the fluid mover 1 through the inlet 10 and plenum 8 causes a jet of steam to issue forth through the nozzle 16. Steam issuing from the nozzle 16 interacts with the working fluid in a section of the passage operating as a mixing chamber (3A). In operation the shockwave 17 is created in the mixing chamber (3A).

[0048] In operation the steam jet issuing from the nozzle occasions induction of the working fluid through the passage 3 which because of its straight through axial path and lack of any constrictions provides a substantially constant dimension bore which presents no obstacle to the flow. At some point determined by the steam and geometric conditions, and the rate of heat and mass transfer, the steam condenses causing a reduction in pressure. The steam condensation occurs immediately in front of the shockwave 17 which is thus formed, which in turn creates a high pressure gradient which enhances the induction of fluid through the passage 3.

[0049] The parametric characteristics of the steam coupled with the geometric features of the nozzle, upstream wall profile and mixing chamber are selected for optimum energy transfer from the steam to the working fluid. The first energy transfer mechanism is momentum and mass transfer which results in atomisation of the working fluid. This energy transfer mechanism is enhanced through turbulencc. Figure 1 shows

diagrammatically the break-up, or atomisation sequence 18 of the working fluid core.

[0050] Figure 2 shows a magnified and exaggerated schematic of the shearing and atomisation mechanism 18 of the working fluid by the transport fluid. It is believed that this mechanism can be broken down into three distinct regions, each governed by established turbulence mechanisms. The first region 20 experiences the first interaction between the transport and working fluid. It is in this region that instabilities in the surface contact layer of the working fluid may start to develop. It is believed that these instabilities may grow due to the shear conditions, leading to Rayleigh Taylor ligament break-up 24. Second order eddies within the fluid surface wave may reduce in size to the scale of Kolmogorov eddies 22. It is believed that the formation of these eddies, in association with the Rayleigh Tayler ligament break-up, which result in the formation of small droplets 28 of the working fluid.

[0051] The droplet formation phases may also result in a localised recirculation zone 26 immediately following the ligament break-up region. This recirculation zone may enhance the fluid atomisation further by re-circulating the droplets back into the shear region.

[0052] The primary break-up mechanism of the working fluid core may therefore be enhanced by creating initial instabilities in the working fluid flow. Deliberately created instabilities in the transport fluid/working fluid interaction layer encourage fluid surface turbulent dissipation resulting in

the working fluid core dispersing into a liquid-ligament region, followed by a ligament-droplet region.

[0053] Referring now to Figure 3 the fluid mover of Figure 1 and 2 is provided with a contoured internal wall in the region 19 immediately upstream of the exit of the steam nozzle 16. The internal wall of the flow passage 3 immediately upstream of the nozzle 16 is provided with a tapering wall 30 to provide a converging profile leading up to the exit of the steam nozzle 16. The converging wall geometry provides a deceleration of the localised flow, providing disruption to the boundary layer flow and in turn leading to the generation of turbulence in this part of the working fluid flow. As this turbulence is created immediately prior to the interaction between the working fluid and the transport fluid, the instabilities initiated in the region enhance the ligament and droplet formation as foreshadowed in the foregoing description.

[0054] An alternative embodiment is shown in Figure 4. Again, the fluid mover of Figure 1 and 2 is provided with a contoured internal wall 19 of the flow passage 3 immediately upstream of the nozzle 16. The contoured surface in this embodiment is provided by a converging wall 30 on the bore surface leading up to the exit of the steam nozzle 16, but the taper is preceded with a step 32. In use, the step results in a sudden increase in the bore diameter prior to the tapered section. The step 'trips' the flow, leading to eddies and turbulent flow in the working fluid within the diverging section, immediately prior to its interaction with the steam issuing from the steam nozzle 16.

[0055] The tapered diverging section 30 could be tapered over a range of angles and may be parallel with the walls of the bore. It is even envisaged that the tapered section 30 may be tapered to provide a converging geometry, with the taper reducing to a diameter at its intersection with the steam nozzle 16 which is preferably not less than the bore diameter.

[0056] The embodiment shown in Figure 4 is illustrated with the initial step 32 angled at 90° to the axis of the bore 3. As an alternative to this configuration, the angle of the step 32 may display a shallower or greater angle suitable to provide a 'trip' to the flow. Again, the diverging section 30 could be tapered at different angles and may even be parallel to the walls of the bore 3. Alternatively, the tapered section 30 may be tapered to provide a converging geometry, with the taper reducing to a diameter at its intersection with the steam nozzle 16 which is preferably not less than the bore diameter.

[0057] Figures 5 to 8 illustrate examples of alternative contoured profiles. All of these are intended to create turbulence in the working fluid flow immediately prior to the interaction with the transport fluid issuing from the nozzle 16.

[0058] The embodiments illustrated in Figures 5 and 6 incorporate single or multiple triangular cross section grooves 34, 36 immediately prior to a tapered or parallel section 30, which is in turn immediately prior to the exit of the steam nozzle 16.

[0059] The embodiments illustrated in Figures 7 and 8 incorporate single or multiple triangular 38 and/or square 40 cross section grooves a short distance upstream of the exit of

the steam nozzle 16. These embodiments are illustrated without a tapering diverging section after the grooves.

[0060] Although Figures 1 to 8 illustrate several combinations of grooves and tapering sections, it is envisaged that any combination of these features, or any other groove cross-sectional shape may be employed.

[0061] The tapered section 30 and/or the step 32 and/or the grooves 34, 36, 38, 40 may be continuous or discontinuous in nature around the bore. For example, a series of tapers and/or grooves and/or steps may be arranged around the circumference of the bore in a segmented or 'saw tooth' arrangement.

[0062] The versatility of the fluid mover is disclosed in the aforementioned patent. It is this versatility that allows the present invention to be applied in many different applications over a wide range of operating conditions. Furthermore the shape of the fluid mover of the present invention may be of any convenient form suitable for the particular application. Thus the fluid mover of the present invention may be circular, curvilinear or rectilinear, to facilitate matching of the fluid mover to the specific application or size scaling. The enhancements of the present invention may be applied to the fluid mover in any of these forms.

[0063] The fluid mover of the present invention thus has wide applicability in industries of diverse character ranging from the food industry at one end of the chain to waste disposal at the other end.

[0064] The present invention when applied to the fluid mover of the aforementioned patent affords particularly enhanced emulsification and homogenisation capability. Emulsification is also possible with the deployment of the fluid mover of the present invention on a once-through basis this obviating the need for multi-stage processing. In this context also the mixing of different liquids and/or solids is enhanced by virtue of the improved shearing mechanism which affects the necessary intimacy between the components being brought together as exemplified heretofore.

[0065] The heating of fluids and/or solids can be effected by the use of the present invention with the fluid mover by virtue of the steam input as the transport fluid and of course in this respect the invention has multi-capability in terms of being able to pump, heat, mix and disintegrate etc.

[0066] The fluid mover of the present invention may be utilised, for example, in the essence extraction process. In this example the fluid mover may be utilised to pump, heat, entrain, hydrate and intimately mix a wide range of aromatic materials with a liquid, usually water.

[0067] As has been disclosed above, the fluid mover of the present invention possesses a number of advantages in its operational mode and in the various applications to which it is relevant. For example the 'straight-through' nature of the fluid mover having a substantially constant cross section, with the bore diameter never reducing to less than the bore inlet, means that not only will fluids containing solids be easily handleable but also any rogue material will be swept through the mover without impedance. The fluid mover of the present

invention is tolerant of a wide range of particulate sizes and is thus not limited as are conventional ejectors by the restrictive nature of their physical convergent sections.

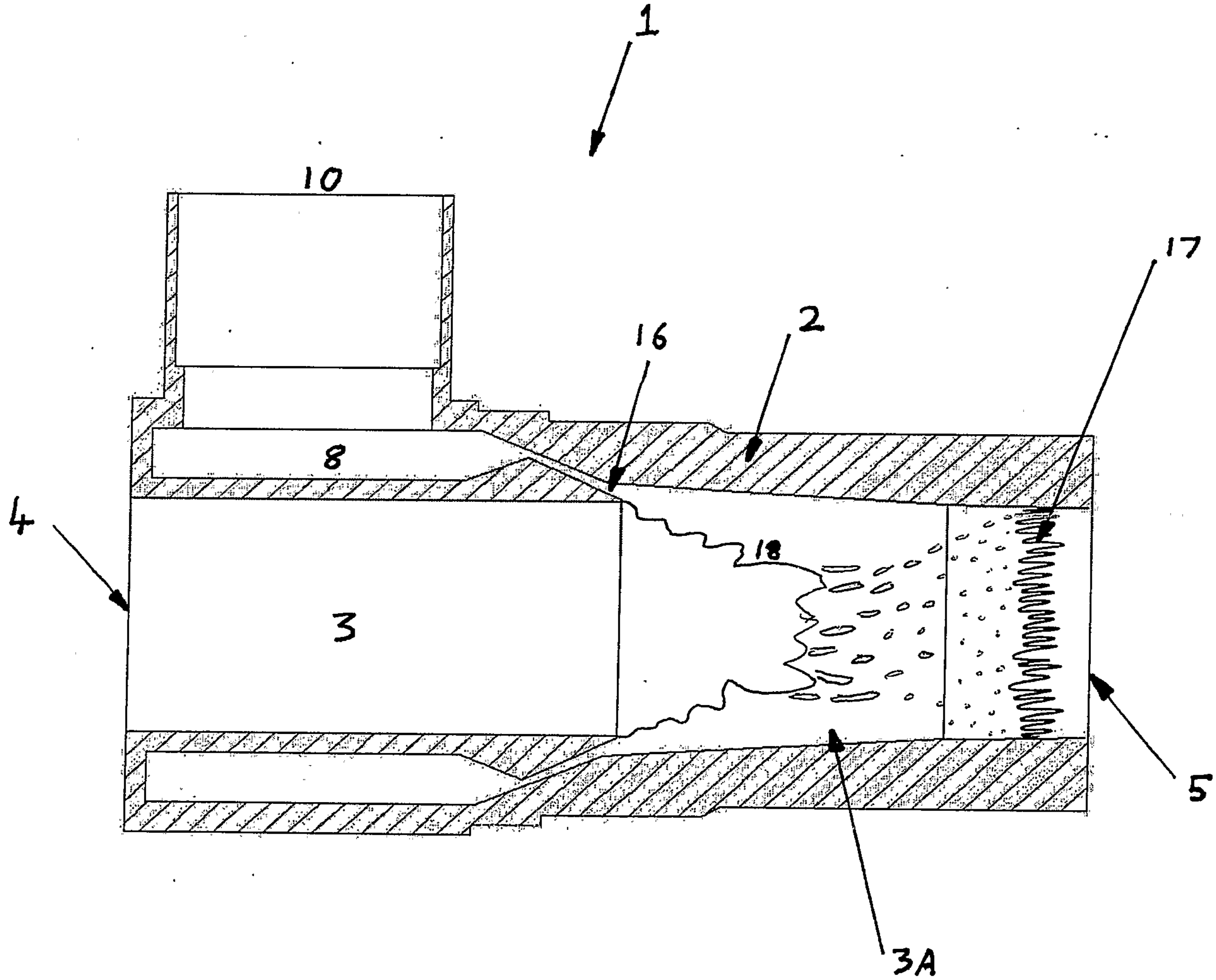


Figure 1

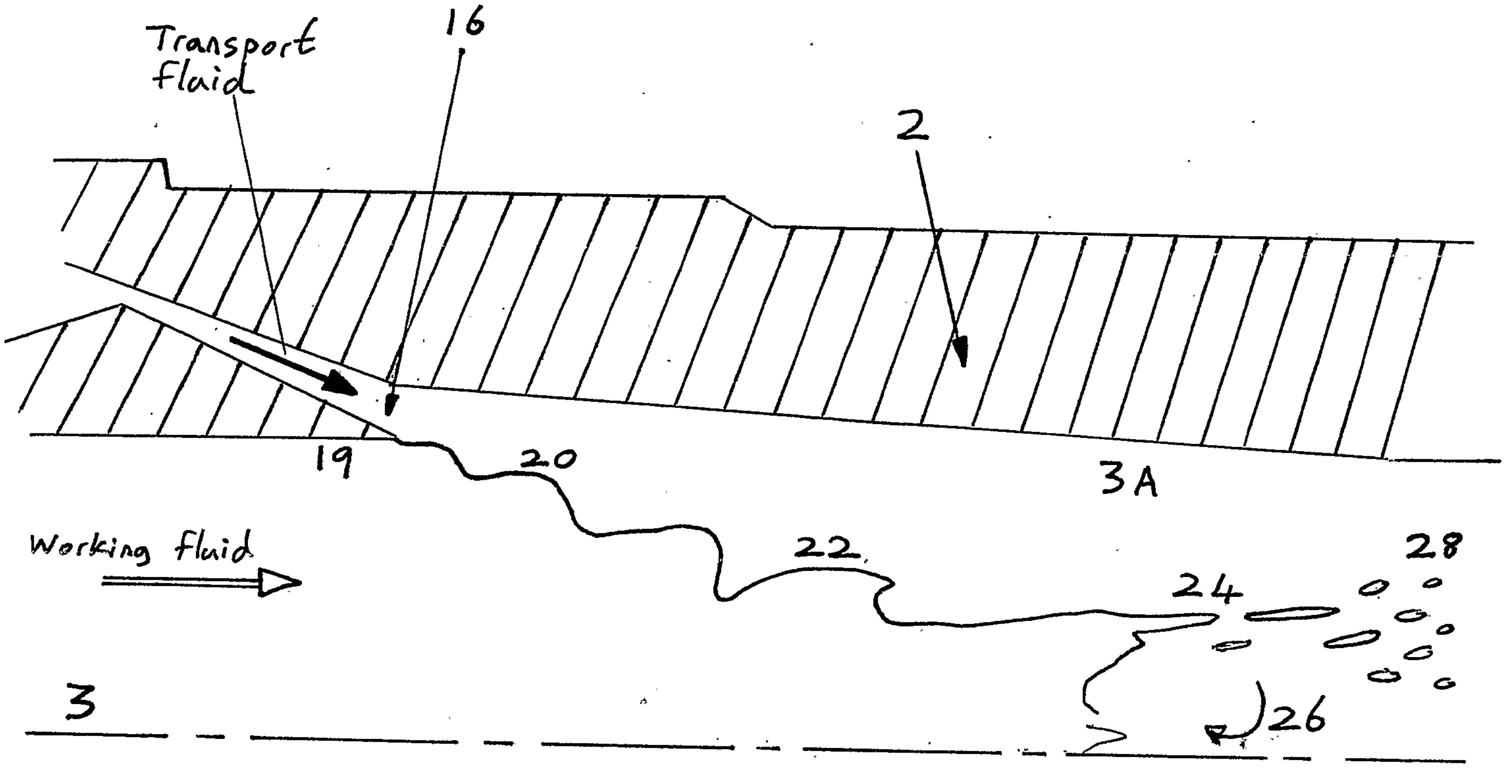
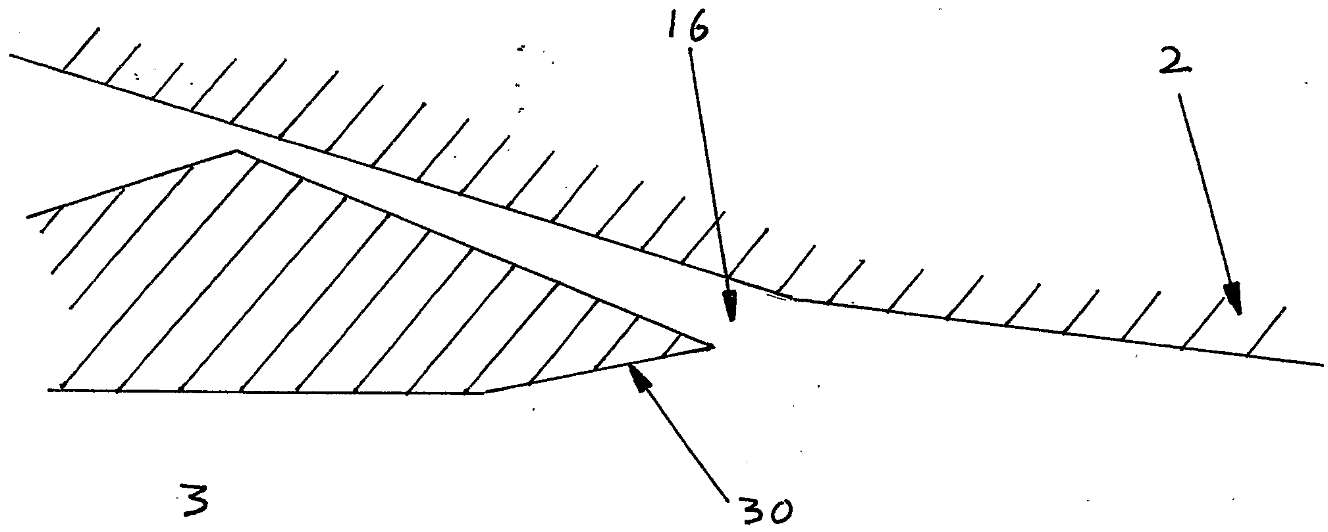


figure 2



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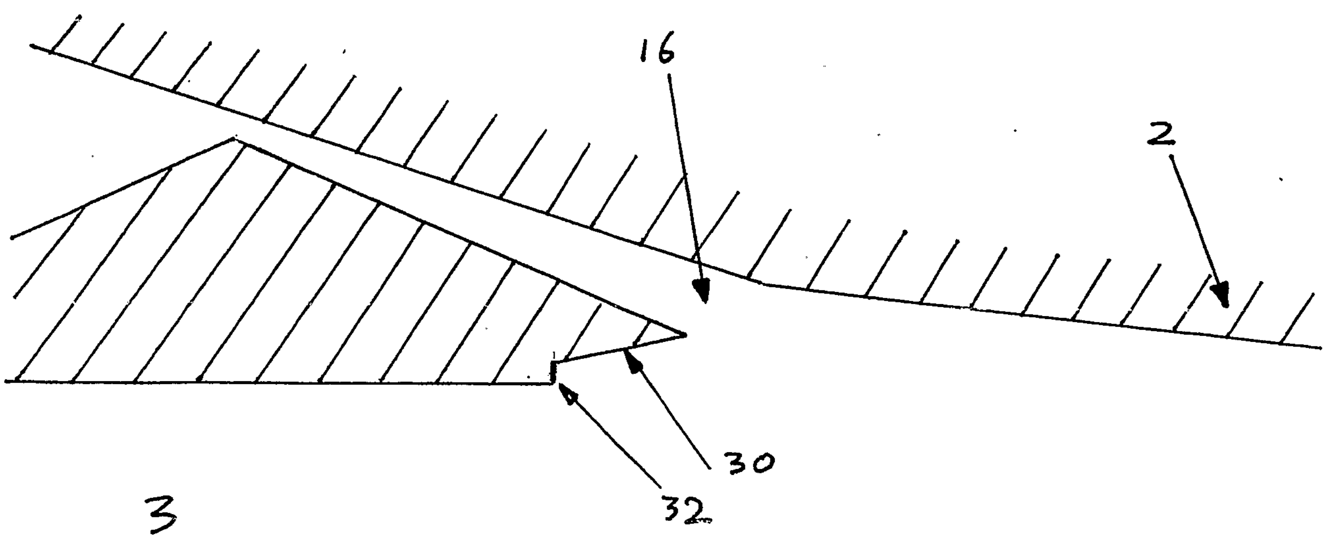

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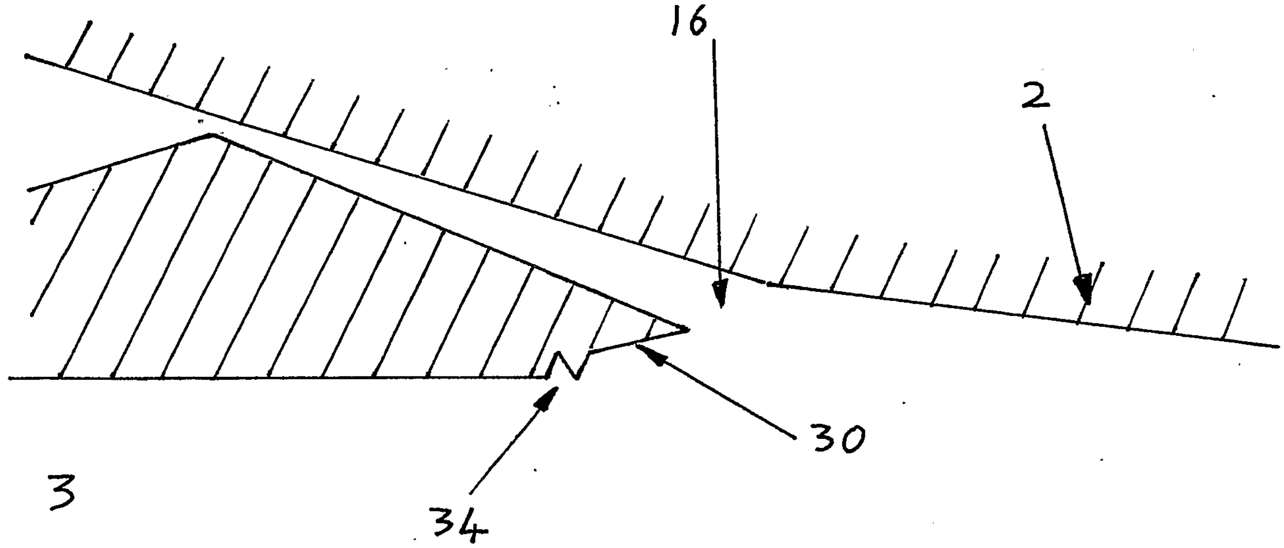

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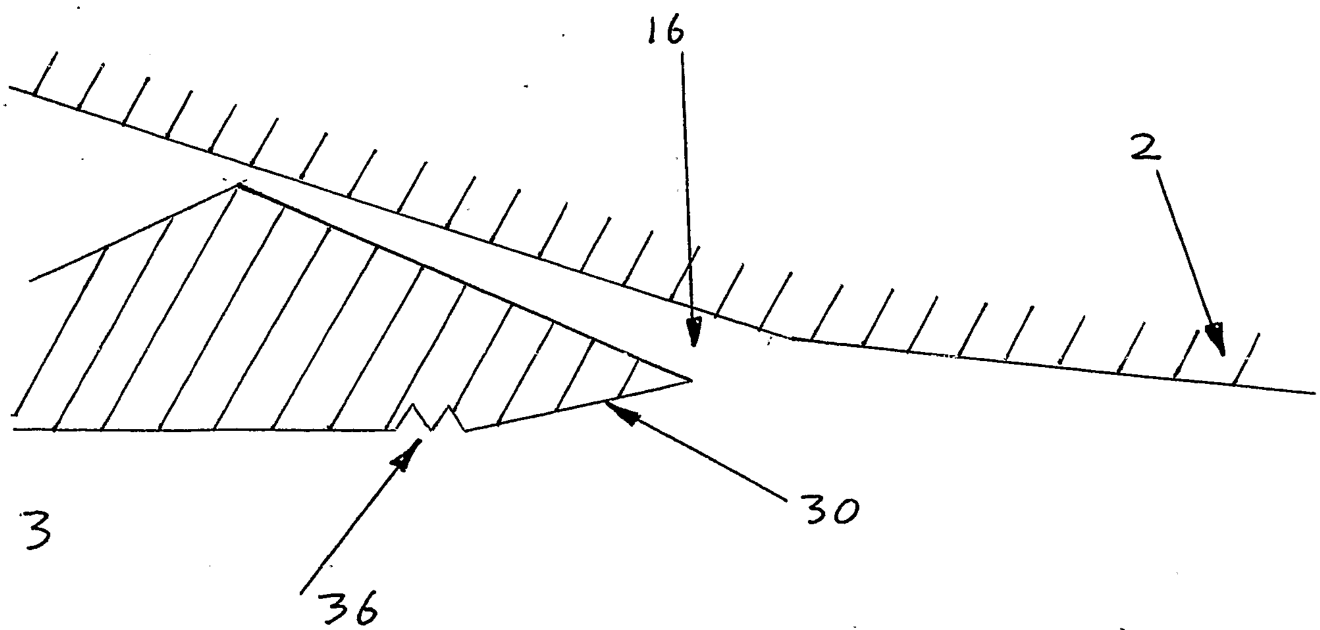

figure 6

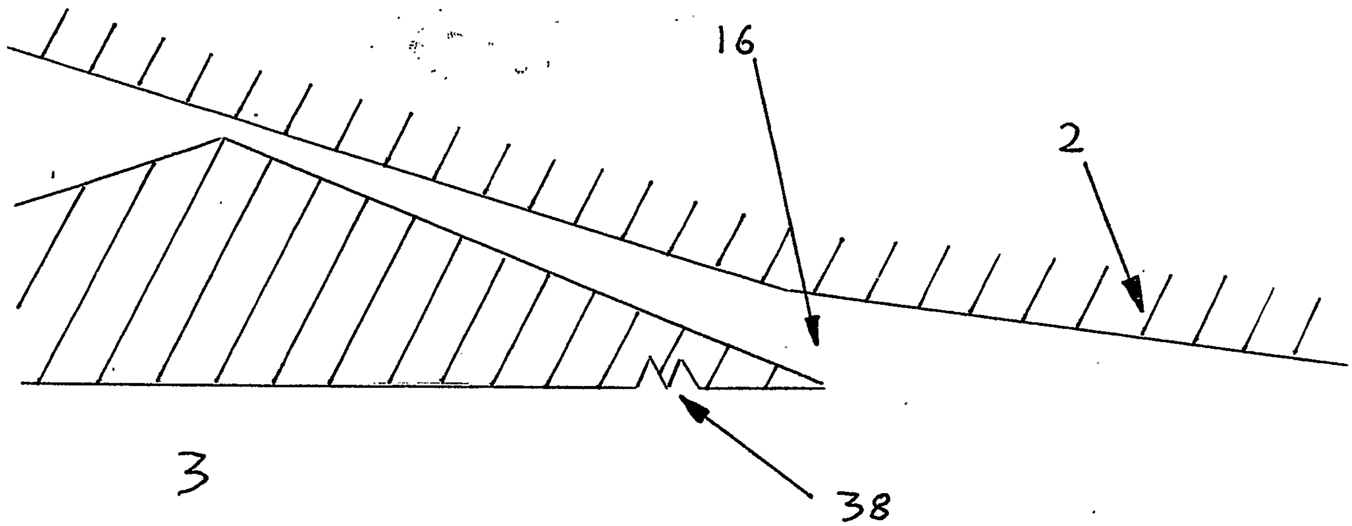

figure 7

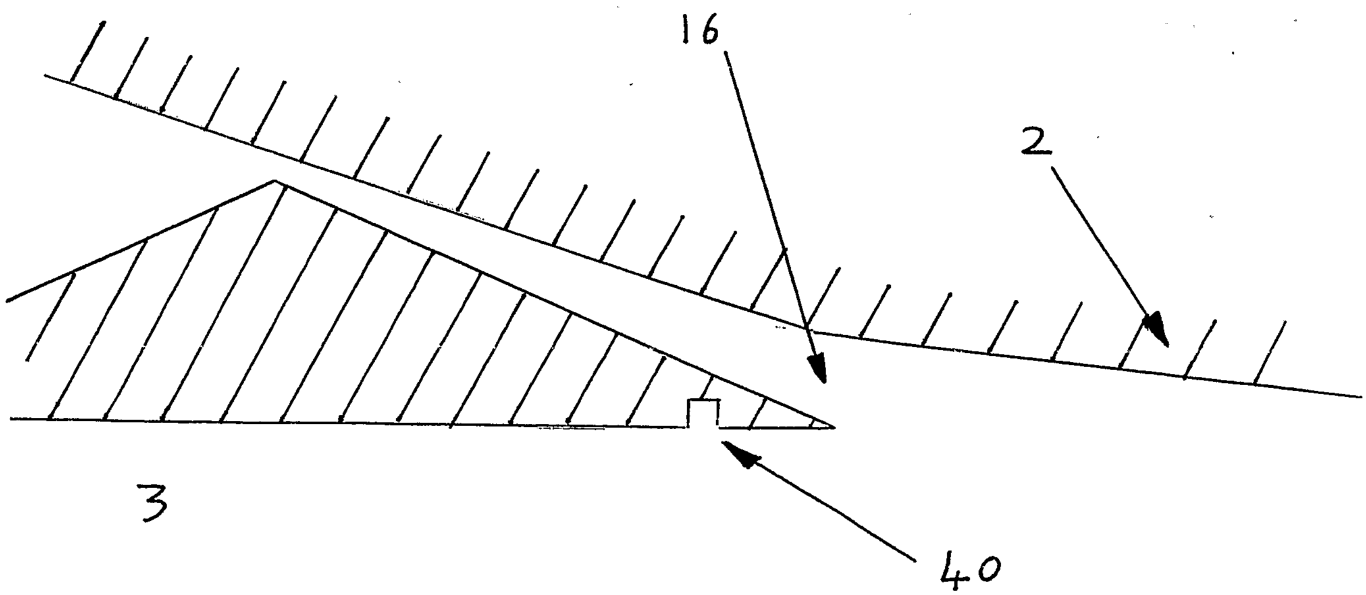

figure 8